

ANNUAL PROGRESS REPORT #2

FOR GRANT

NAG5-12668

WAVELENGTHS, f -VALUES, AND CROSS SECTIONS IN THE UV SPECTRA

OF ASTROPHYSICAL ATOMS, IONS, AND MOLECULES

FOR THE PERIOD 15 JANUARY 2004 THROUGH 14 JANUARY 2005

PRINCIPAL INVESTIGATOR

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PREPARED FOR

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THE SMITHSONIAN ASTROPHYSICAL OBSERVATORY
IS A MEMBER OF THE
HARVARD-SMITHSONIAN CENTER FOR ASTROPHYSICS

(1) Improved UV wavelengths, energy levels, and f -values for iron group ions.

Data analysis for Fe III was completed in 2004. The new spectra give wavelengths and some energy levels for Fe III that are at least an order of magnitude more accurate than values in the literature. However, the data set is missing – because they are outside the wavelength range that we can study at Imperial College or with ancillary FT spectroscopy measurements at NIST – important transitions that would allow all energy levels to be determined with improved accuracy. We are assessing collaborations at other labs.

We have made test runs with a number of cathodes (pure metals and alloys) in the Penning discharge source and selected four iron group (3d) elements, Cr, Mn, Co, and Ni, for further measurements. Cathodes of pure Cr and Co and an alloy of Ni were found to be best. Mn has not run stably yet, and other cathode geometries or alloys may need to be assessed.

Optimum Penning discharge (PD) lamp conditions (buffer gas, gas pressure, and current/voltage) were established for Co, and investigations are underway for Cr and Ni. Definitive measurements for Co await purchase of new mirrors and photomultiplier tubes that will improve signal to noise ratio.

Our plan for the next year is to continue evaluating cathodes and operating conditions through March '05, and then to begin definitive measurements. The UV wavelength measurements made at Imperial College with the unique UV FT spectrometer will be complemented by visible and near IR range measurements at NIST in June and/or July. Approximately one year from now, we intend to visit Lund University to collaborate on lifetime measurements that will allow our branching ratio data to be used to determine f -values.

(2) Update of Kurucz database of wavelengths and f -values.

No progress. We anticipate returning to this work in mid-2005.

(3) Publication of improved UV photodissociation cross sections for H_2O .

No progress. We anticipate returning to this work in mid-2005.

(4) UV photoabsorption cross sections for CO bands.

No progress. We anticipate returning to this work in mid-2005.

(5) Service Activities and Data Outreach.

Smith reviewed/edited some of contributions to the proceedings of the Joint Discussion on “*Atomic Data for X-Ray Astronomy*” that was held at the last IAU General Assembly. He is a Co-editor of the Proceedings publication that is still in press.

Smith was principal examiner for a laboratory-astronomy-related Ph.D. Thesis defense at Lund University, May 2004.

Smith reviewed a laboratory astrophysics paper for the *Astrophysical Journal*.

Smith was a member of the Scientific Organizing Committee for ASOS-8 (Atomic Spectra & Oscillator Strengths for Astrophysical and Laboratory Plasmas) held in Madison, WI, August 2004.

(6) Poster Papers

Fourier Transform Spectroscopy of Doubly Ionized Transition Group Elements, D. G. Smillie, J. C. Pickering & Peter L. Smith, Royal Astronomical Society National Astronomy Meeting, Open University, Milton Keynes, UK, 01–02 APR 2004,

High resolution Fourier transform spectroscopy of astrophysically important elements, D Smillie, J C Pickering, A P Thorne, R Blackwell-Whitehead, & S Nadj-Perge, 8th European Conference on Atomic and Molecular Physics, University of Rennes 1, Rennes, France, 08–09 JUL 2004,

Atomic Measurements of Doubly Ionised Iron Group Elements by High Resolution Fourier Transform Spectroscopy for Astrophysical Applications, D. G. Smillie, J. C. Pickering, Peter L. Smith, A. P. Thorne & R. J. Blackwell-Whitehead, 8th International Colloquium on Atomic Spectra and Oscillator Strengths for Astrophysical and Laboratory Plasmas, University of Wisconsin, Madison, WI, USA, 10 AUG 2004

Prepared by Peter L. Smith, 10 January, 2005